



Update on Energy Storage Based Power Quality Applications in South Africa

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Introduction to Eskom - U. Stell. Research



Research Field: Power conversion and control

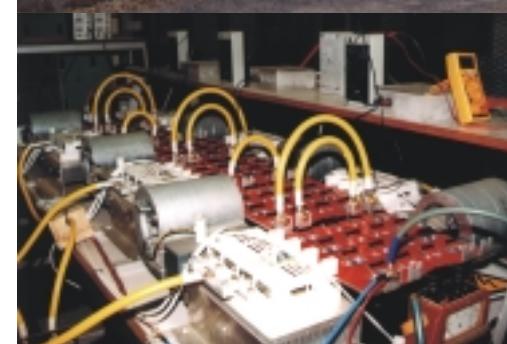
The general need for:

- Lower capital investment
- Lower risk
- Turn-key solutions
- Smaller environmental impact

drives new opportunities for modern power semiconductors and processors

SA most significant need areas

- Sensitive customer requirements
- Rural electrification drive from government
- Rural agriculture need for electrical energy
- Increasing peak demands due to electrification

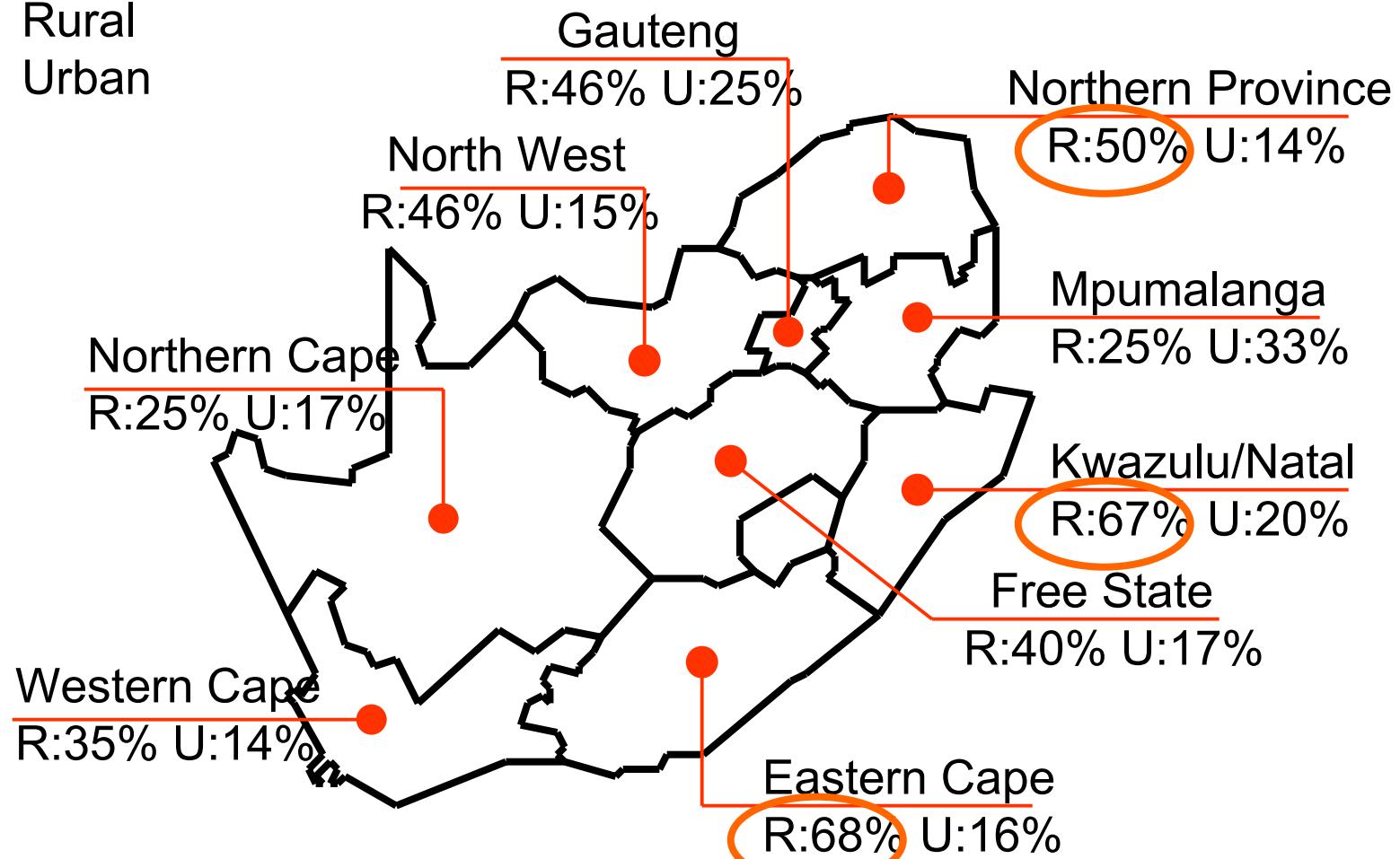




38% households not electrified

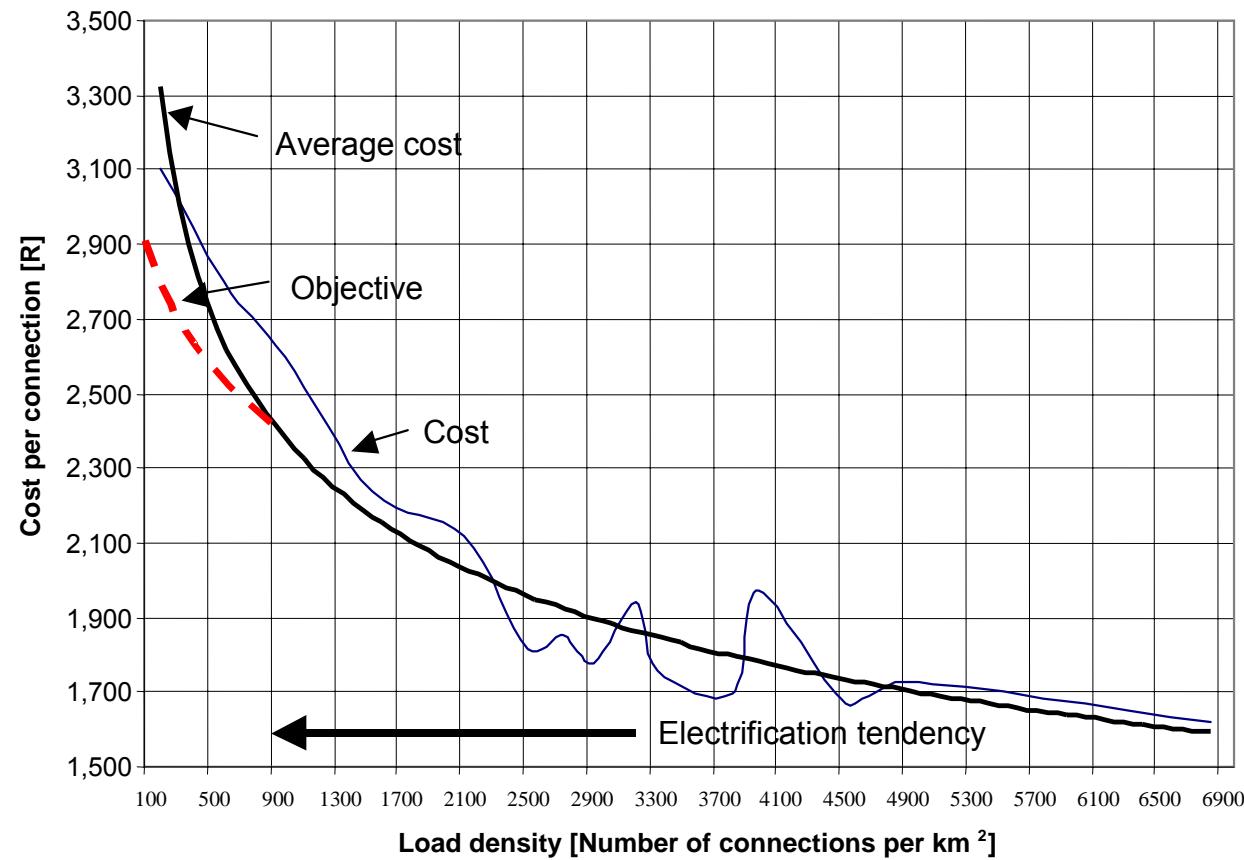


R: Rural
U: Urban





Opportunities





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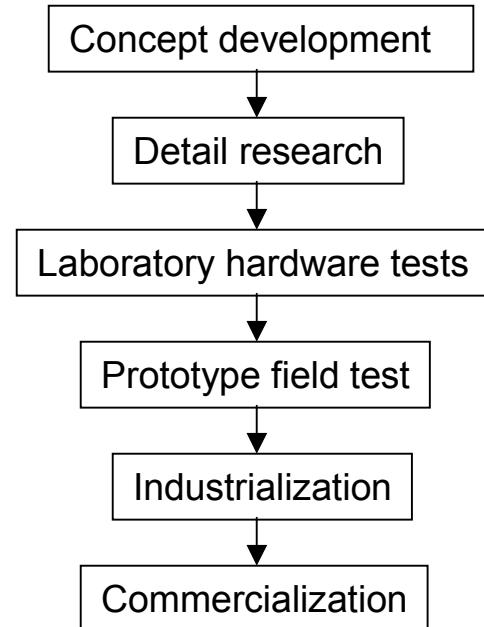


Power system applications:

- Power quality mitigation
- Network compensation
- Load compensation
- System stabilization

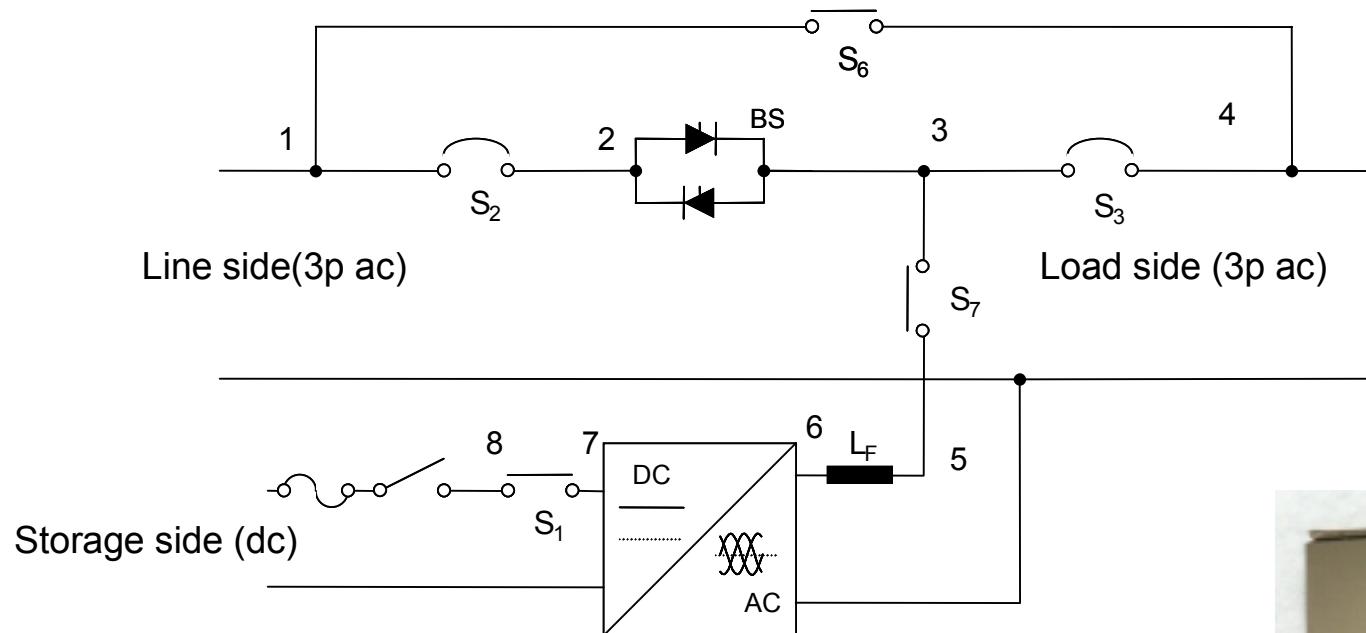
Employing:

- Power electronics
- Energy storage
- Distributed generation
- Alternative energy resources



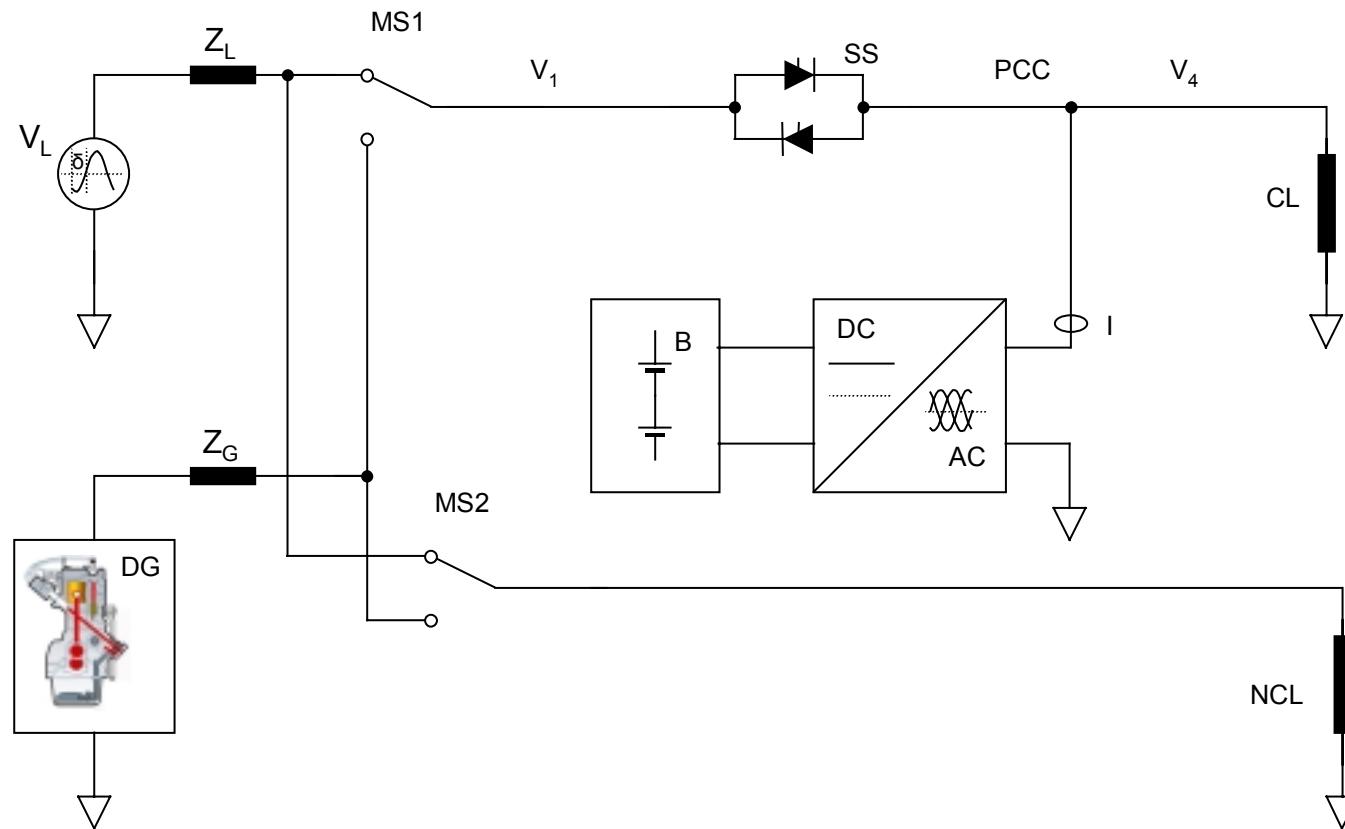


DPQC-P-250 Device Configuration





System Configuration – LA Batteries



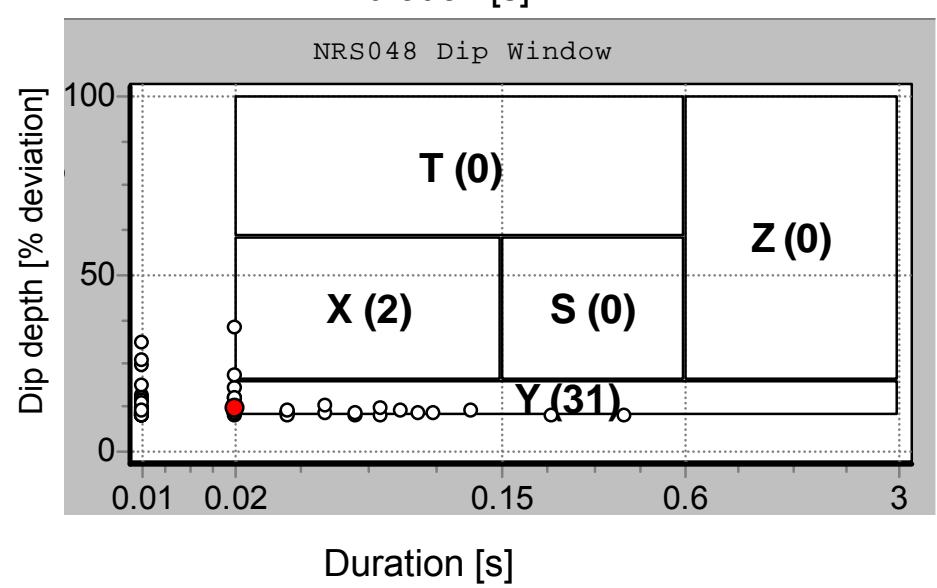
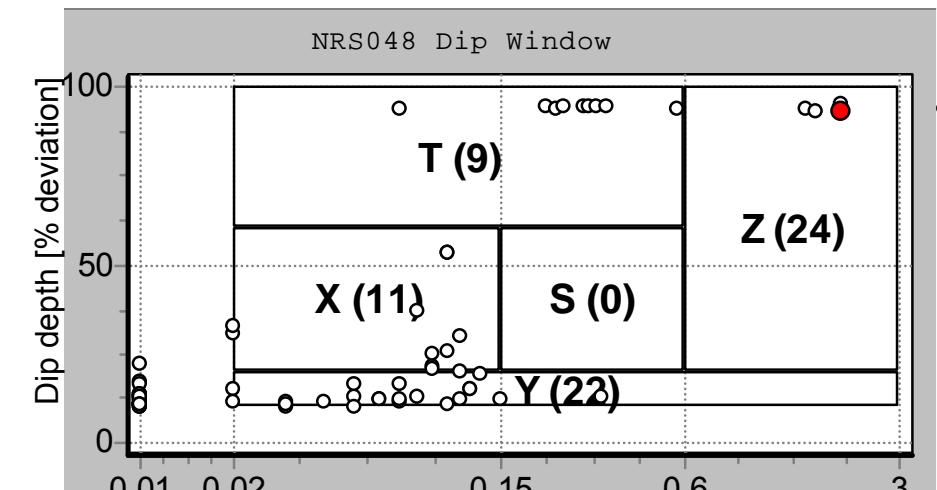
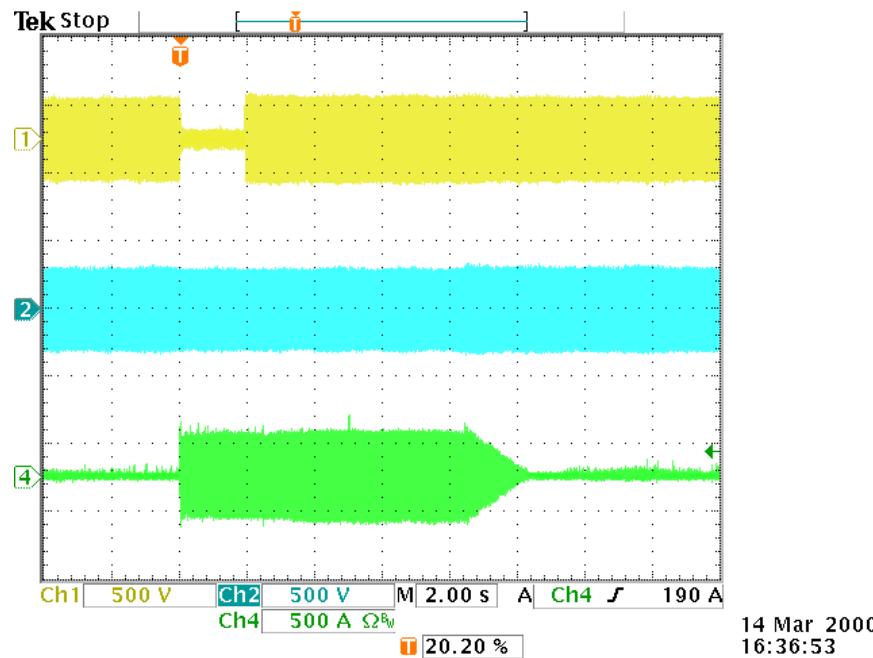


Kameeldrift Installation



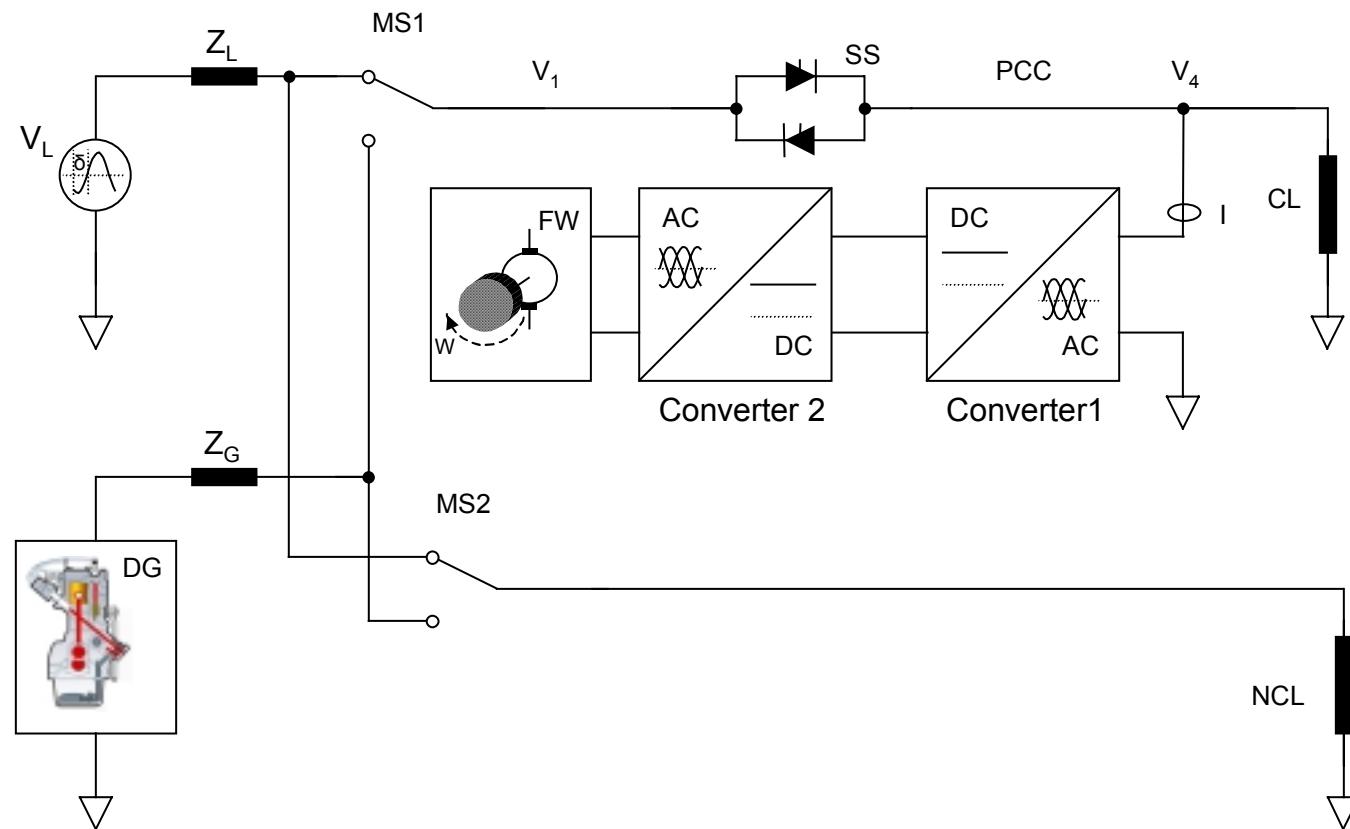


Kameeldrift Installation: Results





System Configuration – Flywheels





Stellenbosch Installation: DPQC-P-FW





System Ratings



DPQC:

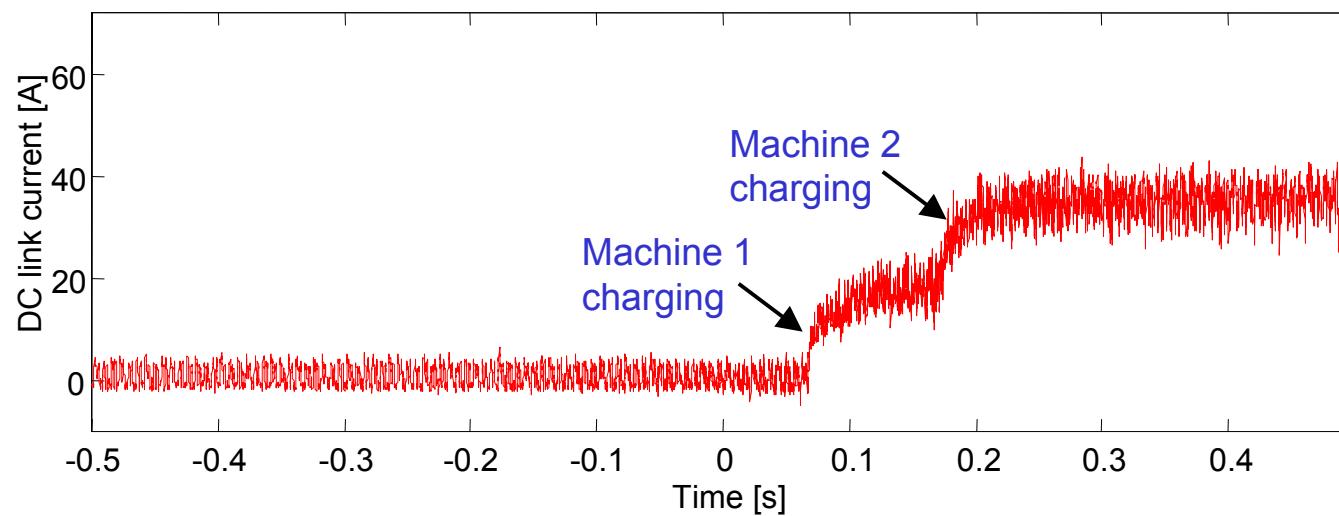
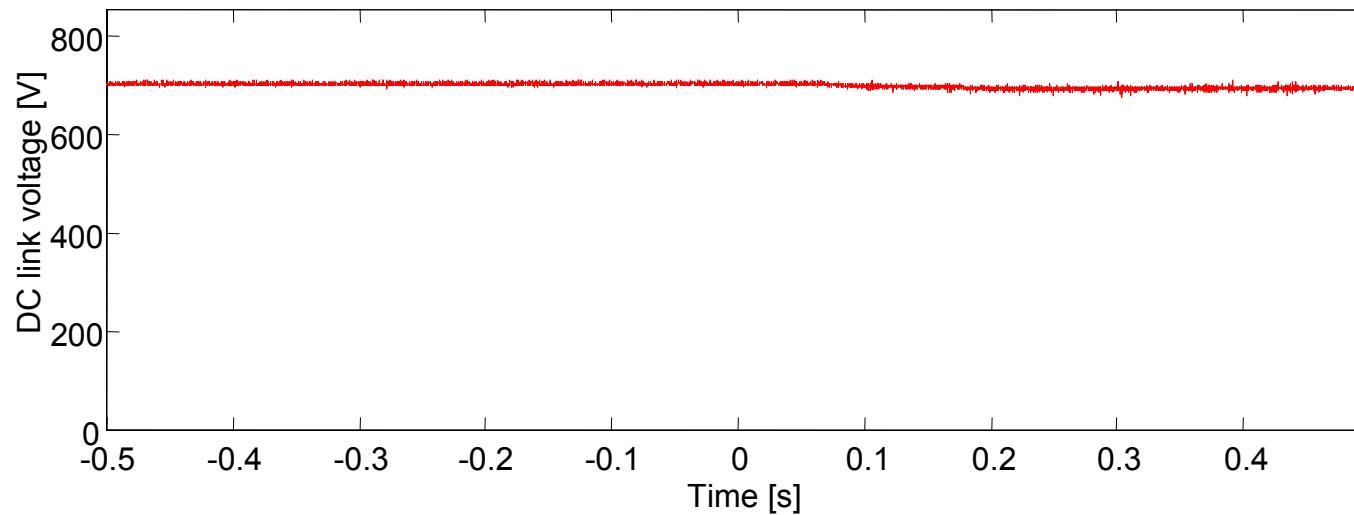
- 230 V \pm 10% output voltage
- 250 kW load power
- Dips and interruptions compensated

Flywheels:

- 200 kW combined output power
- Discharge time at maximum power – 30 seconds (67 seconds measured)
- Steady state losses – 1200 W
- Charging / Discharging efficiency for one operation > 90%
- Operating speed – 36 000 rpm
- Design life > 20 years
- Number of full discharges > 10 000 000
- Rapid response < 5 ms
- Maintenance – none for rotating parts, vacuum pump oil check twice per year

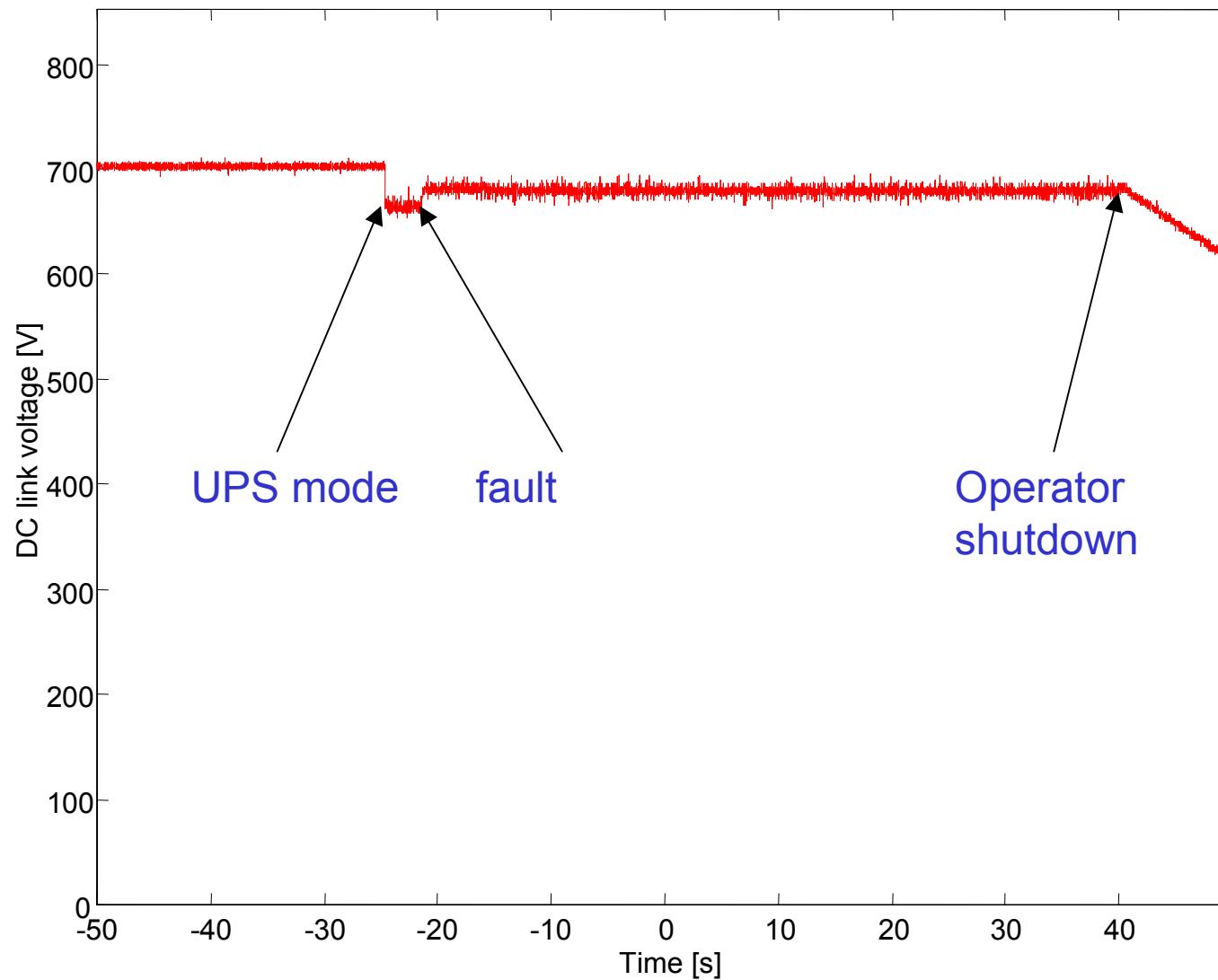


Charging cycle



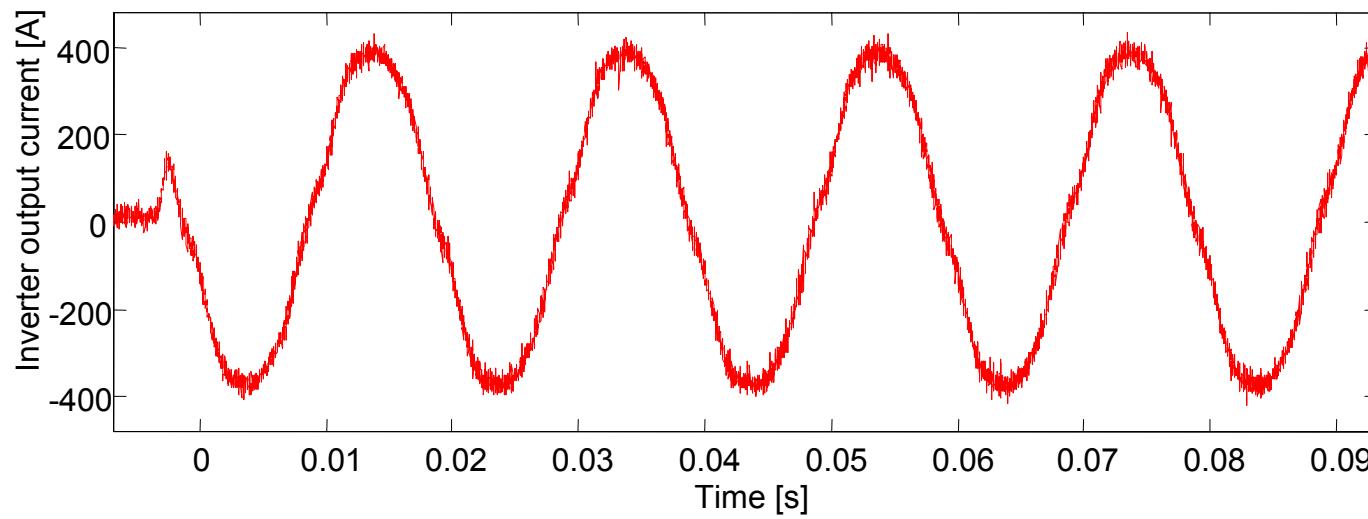
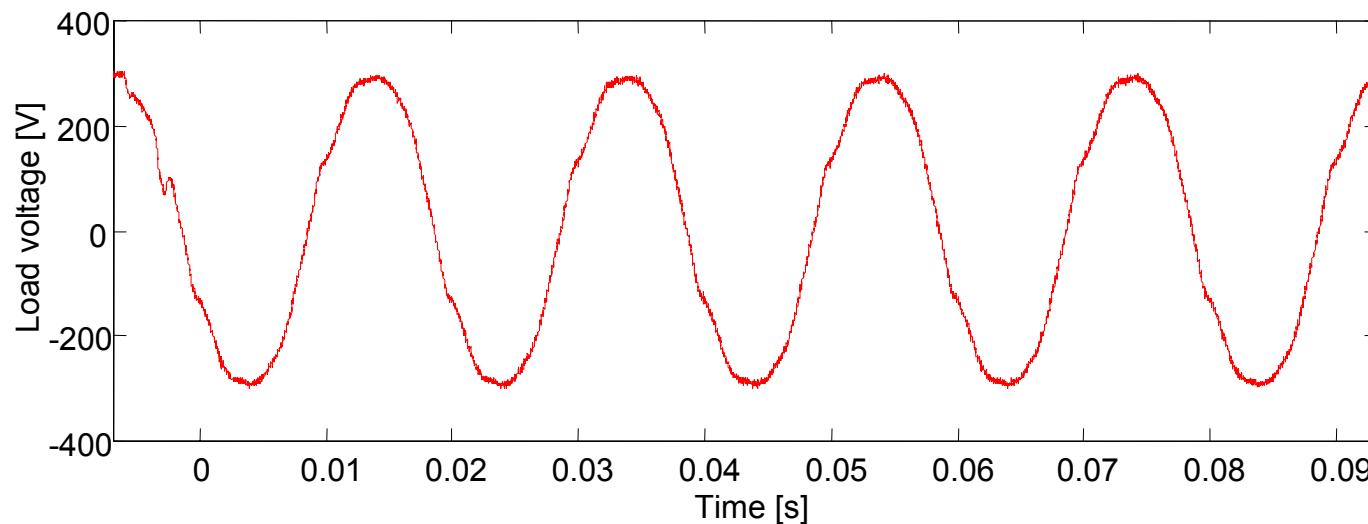


Discharging cycle with fault and shutdown

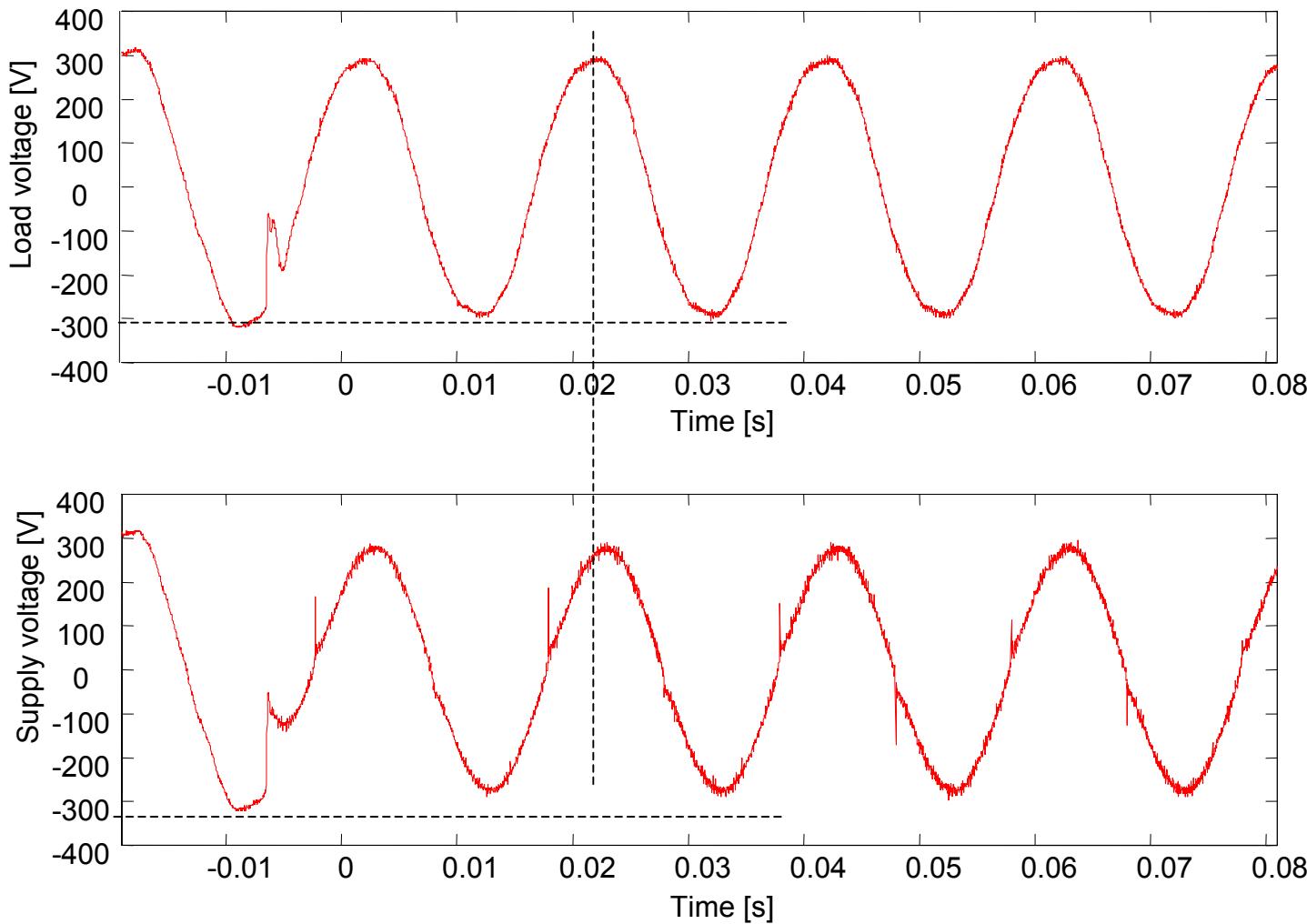




Discharging cycle - interruption



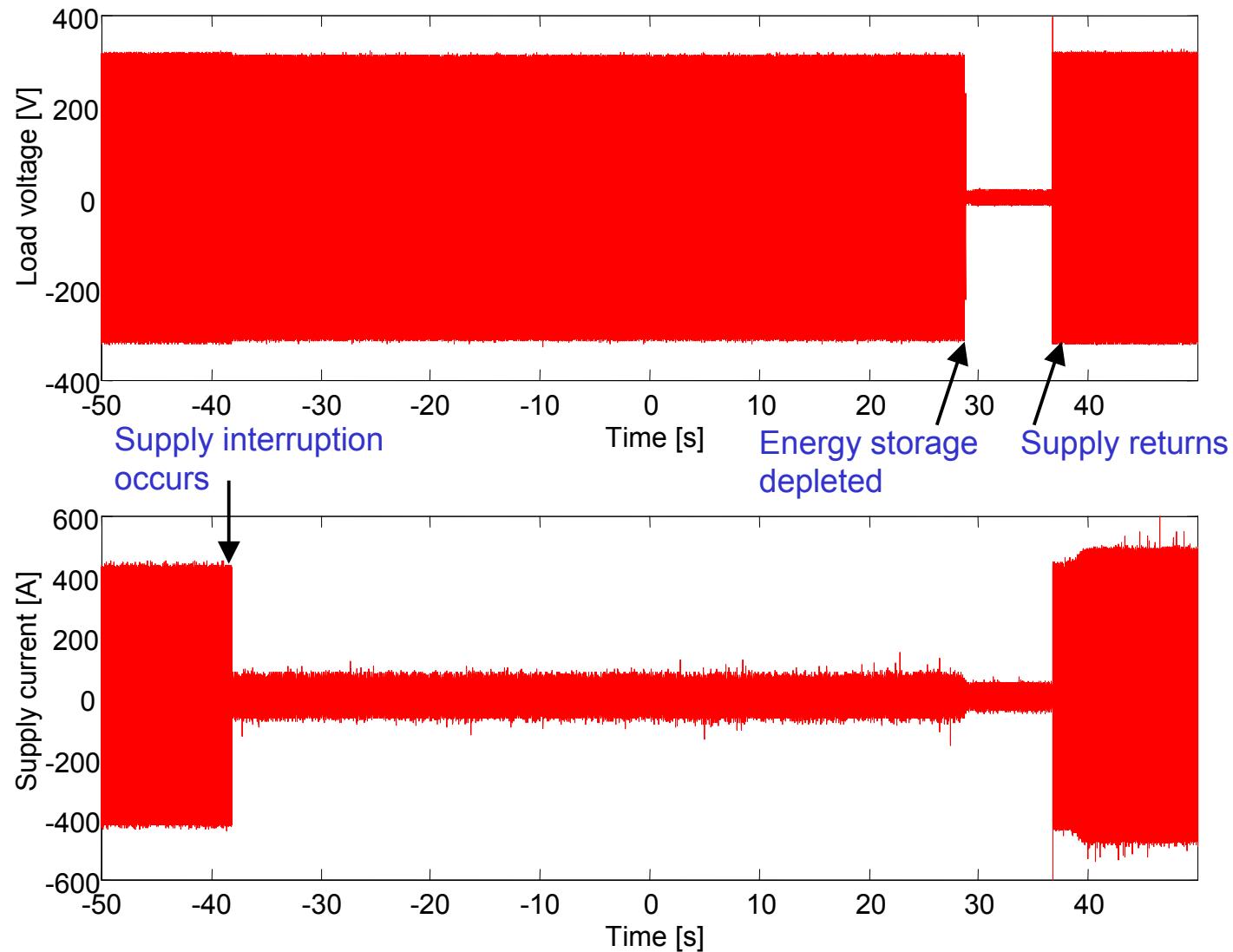
Discharging cycle - dip



- Load voltage = 93% of 230 V and no phase shift
- Supply voltage = 85% of 230 V and phase shifted
- Response time = 2 ms
- Spikes on supply voltage = dip generator's thyristor commutation spikes



Full FW Discharge at 200kW





Kameeldrift Installation

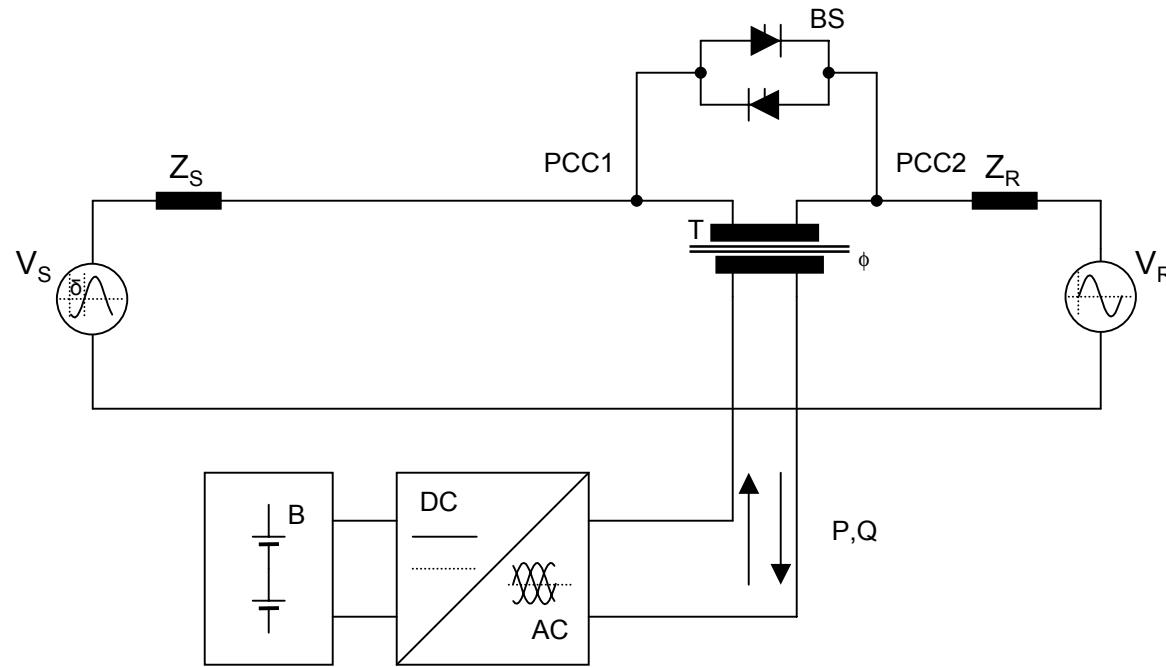




Future Work: DPQC-S-250



The development of the DPQC-S, an industrialized series compensator.

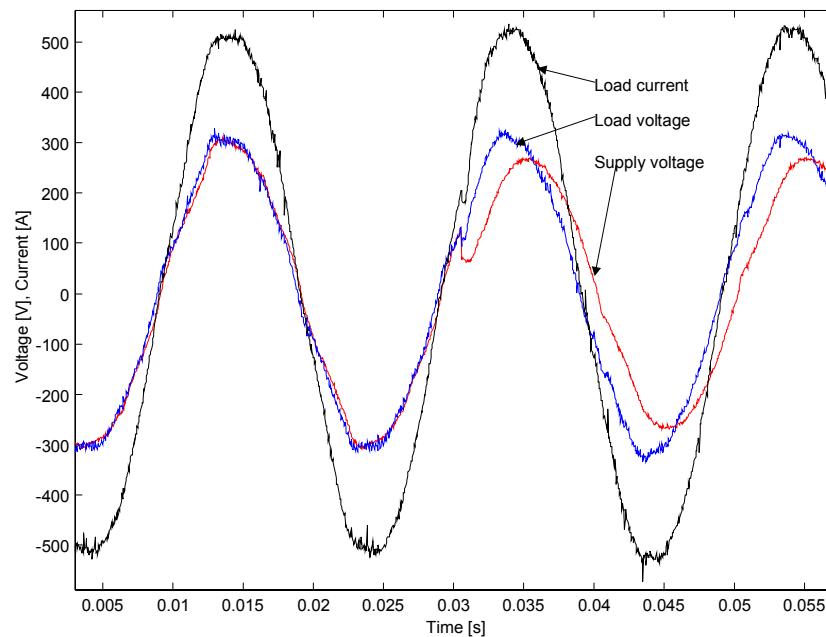




Future Work: DPQC-S-250



Full system operation and evaluation
with LA batteries



Dip rejection on phase C with 250 kVA three-phase load



Future Work: VRB

